Flying with Gas

A novel method in assessing Altitude associated changes in Atmospheric pressure and its correlation with Intraocular pressure in gas filled eyes post retinal surgery In different Geographical areas.

UK and UAE data

Phase 1

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No financial disclosure

Learning from patients !

- <u>CASE 1 – UK Based</u>
- 65 YO Male
- Successful RRD repair with PPV and 20% SF6 gas
- 9 days post –op patient had family emergency and has t fly home (Europe)
- IOP 17mmHg, 20% gas fill and flat retina

- Am I Safe to fly ?

- CASE 2 – UAE based
- 70 YO female with FTMH
- Lives on 13th floor in skyscraper
- CAN SHE HAVE GAS INSTEAD OF SILICON OIL ?

Background

- Gas tamponades are effective agents in retinal surgery.

- Patients are routinely advised against air travel before the complete absorption of intraocular gas.

- But should every eye with gas tamponade avoid high altitude?

Aim and method

- The aim

present a novel method to determine the safety of different altitudes travelled by patients with intra ocular gas tamponades

- The method

  - Measure atmospheric pressure changes at different altitudes.

  - Computing their effect on IOPs in eye model with various levels of gas fill

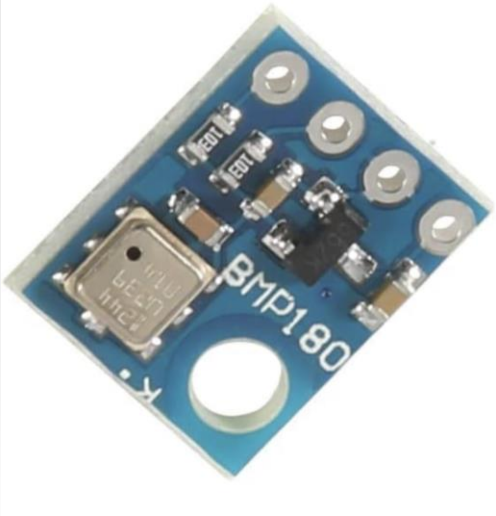
Alterations in atmospheric pressure

- Atmospheric pressures could change in relation to altitudes and air densities.

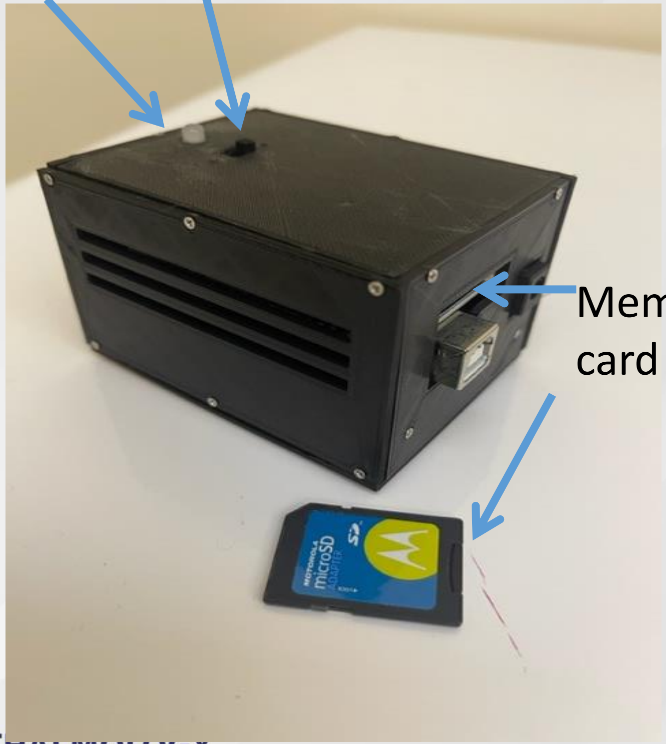
  - Examples of different altitudes include:
    - High mountains
    - High buildings
    - Aeroplanes cabins (pressurised and non-pressurised)
    - Over and Underground train tunnels.

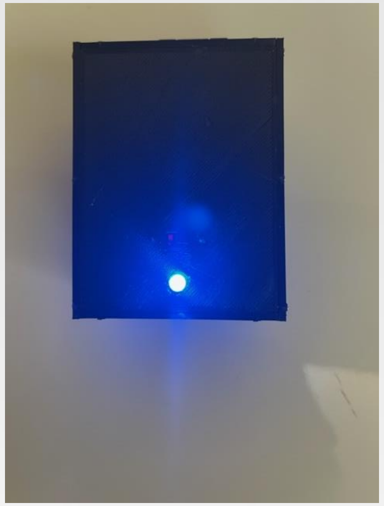
Monitoring atm pressure alteration

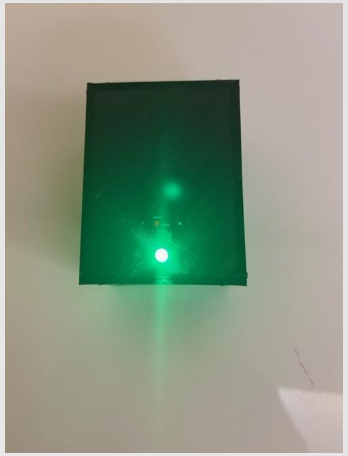
to monitor atmospheric pressure changes we used BMP 180 barometer

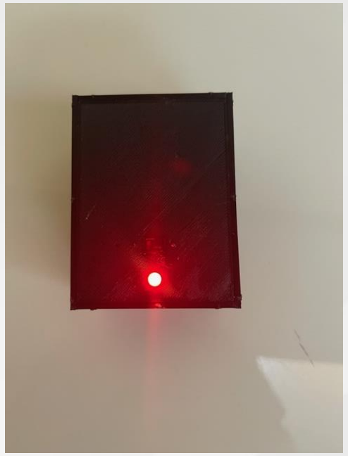


BMP 180 barometer built in different shapes and forms to fit the purpose.









Computing alteration effect

- To compute the corresponding changes in IOP we used an eye model

- A 5 ml chamber with expandable rubber surface.

- The chamber was filled with air and different volumes of 20% SF6

- placed in a jar vacuumed to various levels of atm pressure

- The expansion in the rubber surface was monitored using IR sensors

- Linear regression equation was used to estimate IOP changes for different volumes of gas at different levels of atm pressure.

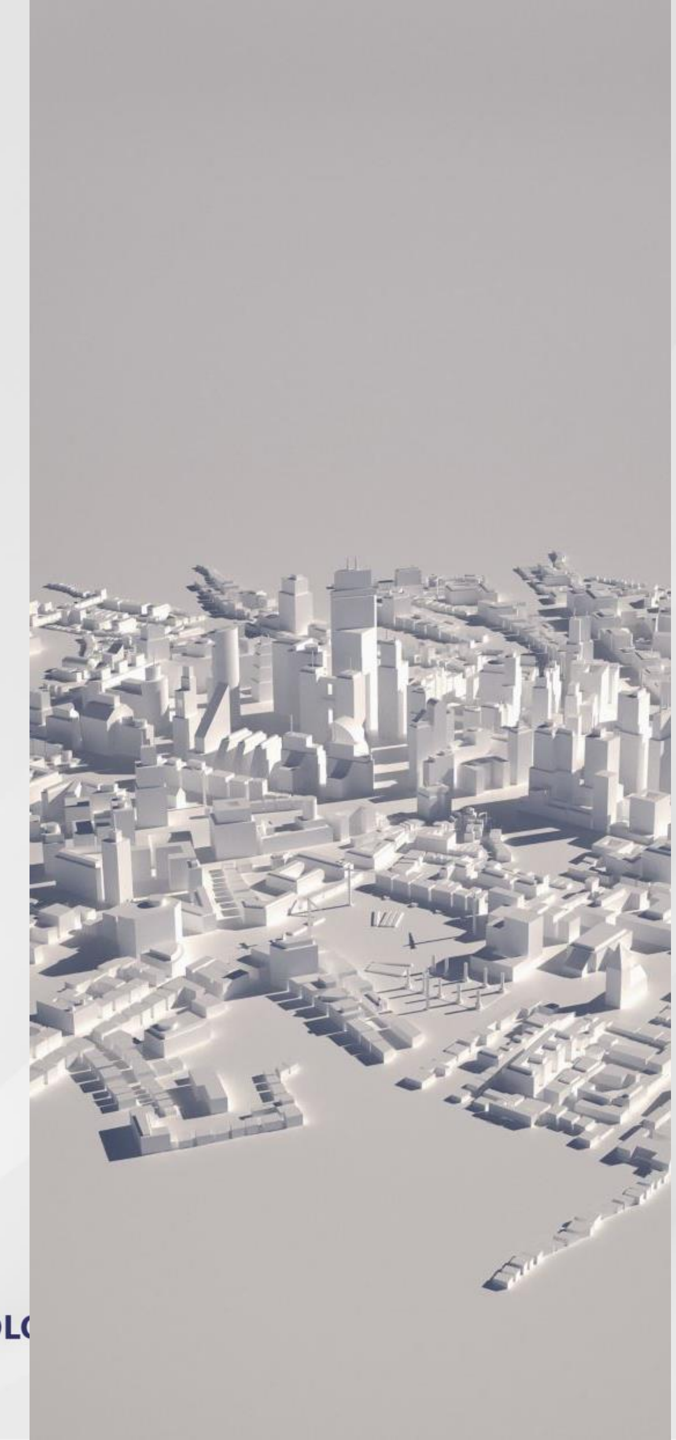
Results

- Results for UK. Under Ground & over ground train trips.
- International flight from LHR – AD airport
- different ROUTES AND ALTITUDES uae

- Jebel hafeet

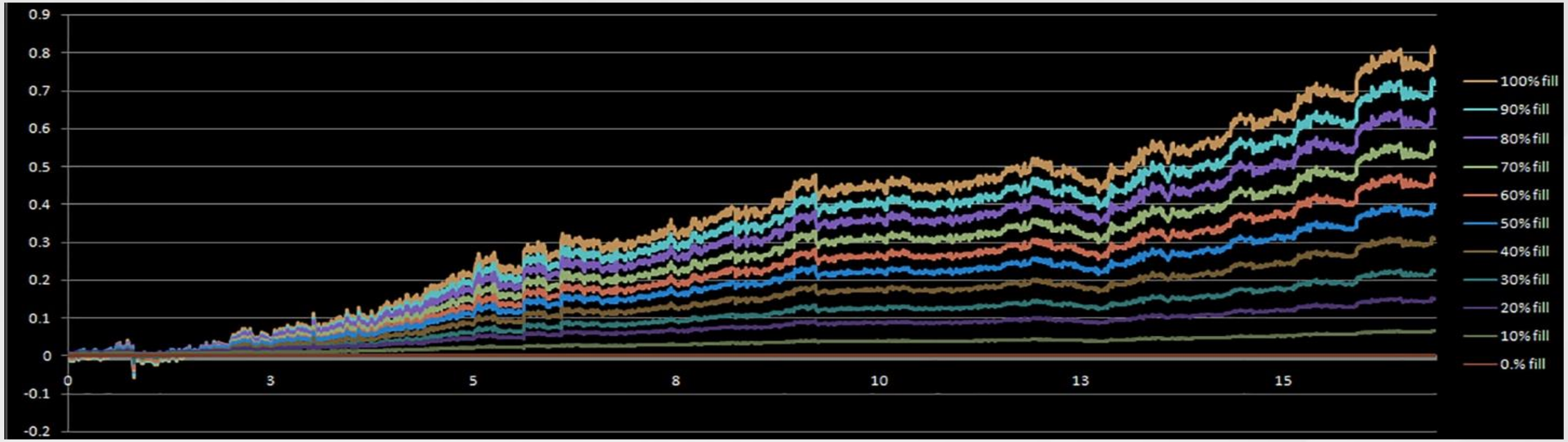
- AA –AD / AA - DXB

- Skyscrapers



UK Data

On a slow over ground train



A patient with 50% fill of SF_6 20% with a baseline IOP of 20mmHg will have an IOP of 20.4mmHg at his point of arrival.

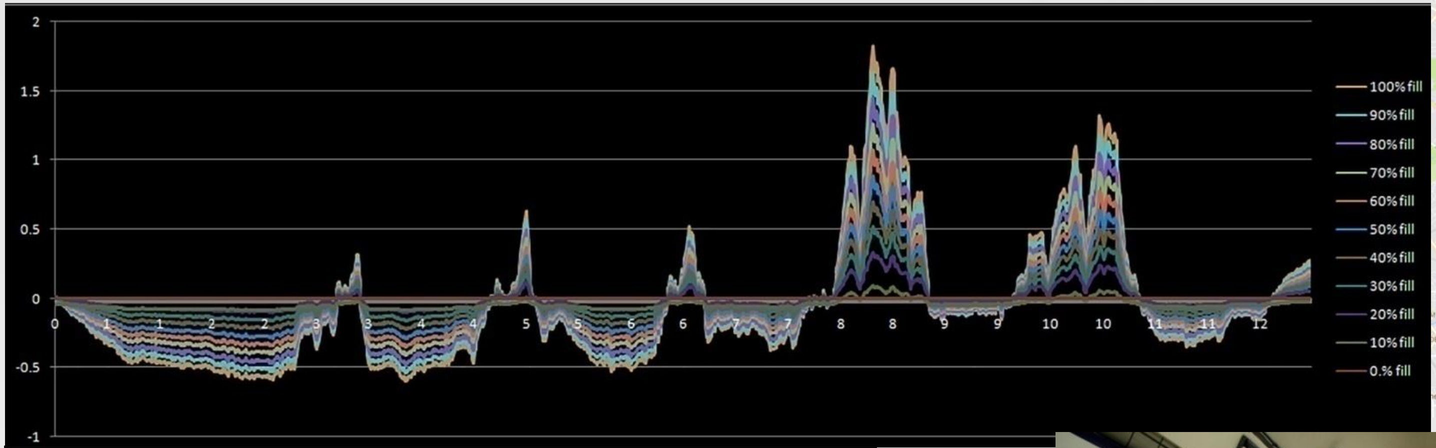
Low risk

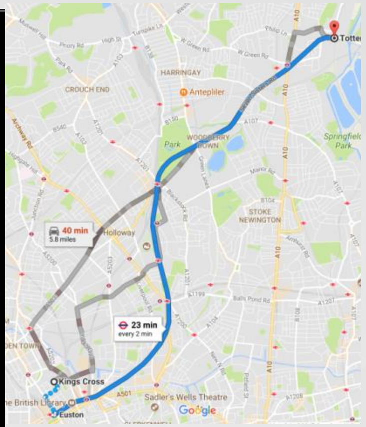
DEPARTURE	Tottenham Hale station
ARRIVAL	Harlow town
TRANSPORT	Train
ALTITUDE	Over ground
DISTANCE	17.6 miles
DURATION	16 minutes
SPEED	66 miles/hr
IOP CHANGE 50% gas fill	0.4 mmHg
PACE OF IOP CHANGE 50% gas fill	0.025 mmHg/minute
DURATION OF MAX IOP	continues at destination
REASON FOR IOP CHANGE	Altitude difference
RISK	Low

On a LONDON underground tube train

A patient with 50% fill of SF_6 20% and a baseline IOP of 20mmHg will have an IOP of 21.40 for 60 seconds.

Low Risk



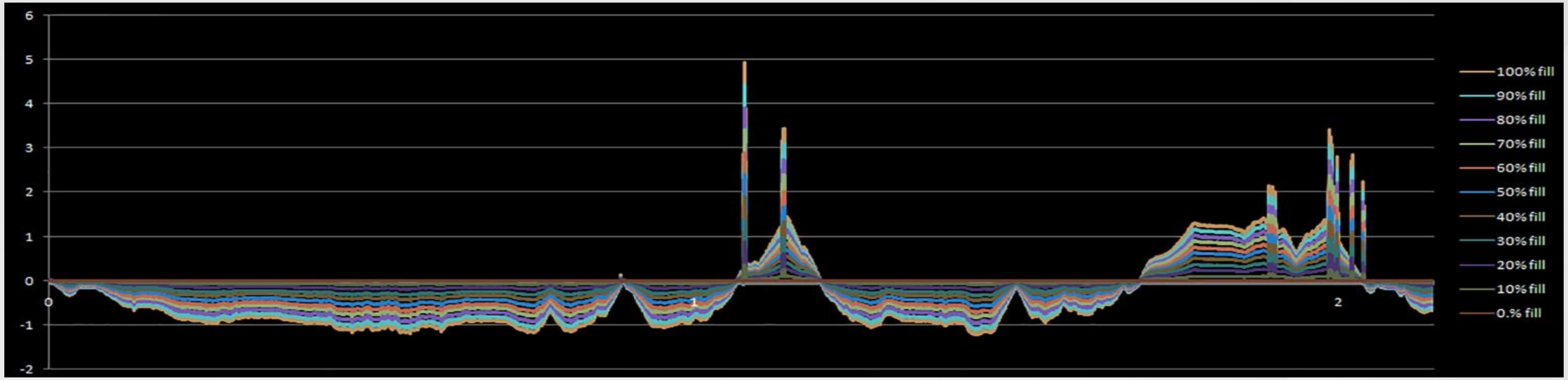


DEPARTURE	Kings Cross station
ARRIVAL	Tottenham Hale Station
TRANSPORT	Underground tube
ALTITUDE	Low
DISTANCE	6 miles
DURATION	12 minutes
SPEED	15.5 miles/hr
IOP CHANGE 50% gas fill	1.39 mmHg
PACE OF IOP CHANGE 50% gas fill	2.78 mmHg/minute
DURATION OF MAX IOP	30-60 seconds
REASON FOR IOP CHANGE	Altitude and air decompresion
RISK	Low

On an over ground fast train departing from Darlington to London

A patient with 50% fill of SF_6 20% and a baseline IOP of 20mmHg will have an IOP of 23.00 for 60 seconds.

Low Risk



DEPARTURE	Darlington
ARRIVAL	London
TRANSPORT	Fast over ground train
ALTITUDE	Neutral
DISTANCE	240 miles
DURATION	2h 37min
SPEED	95 miles/hr
IOP CHANGE 50% gas fill	3 mmHg
PACE OF IOP CHANGE 50% gas fill	2.78 mmHg/minute
DURATION OF MAX IOP	2-3 minutes
REASON FOR IOP CHANGE	Altitude and air decompression
RISK	Low

On a commercial airliner travelling between London Heathrow and AD Airports

DEPARTURE	London Heathrow – AD Int. Airport
TRANSPORT	Boeing 737
DISTANCE	3432 Miles
DURATION	6.5 hours
SPEED	700 miles/hr
IOP CHANGE 50% gas fill	47.53 mmHg
RISK	High

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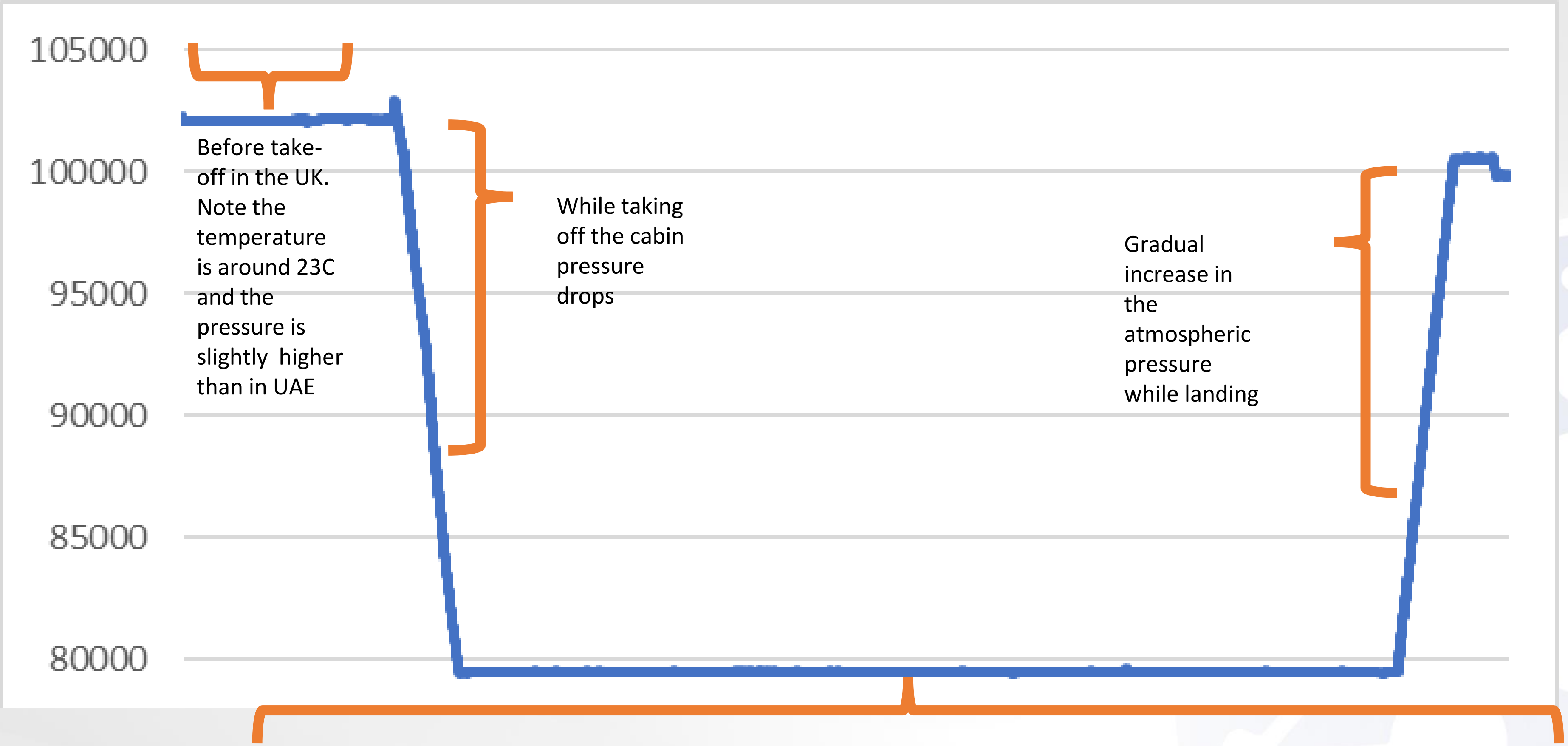
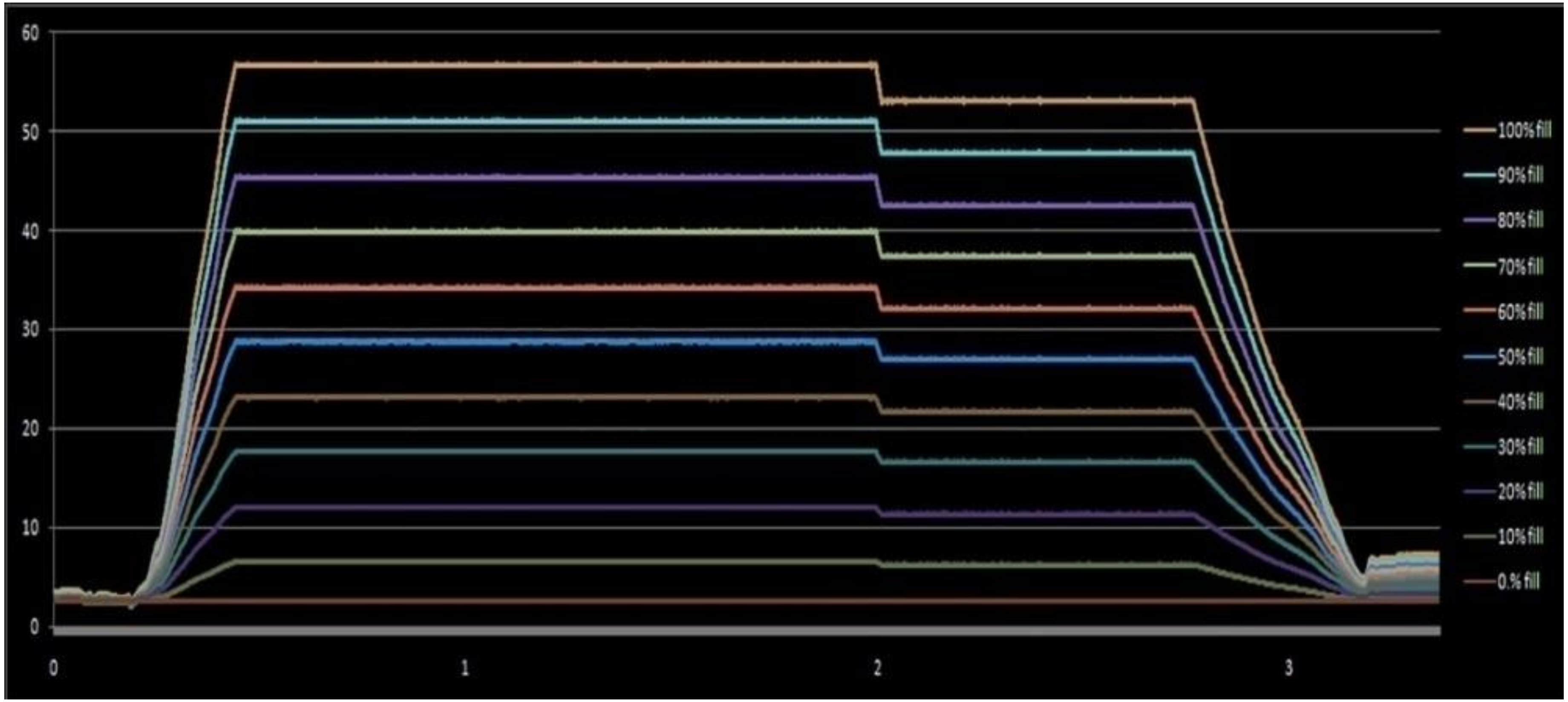
EPOMEC

EXPANDING VISION

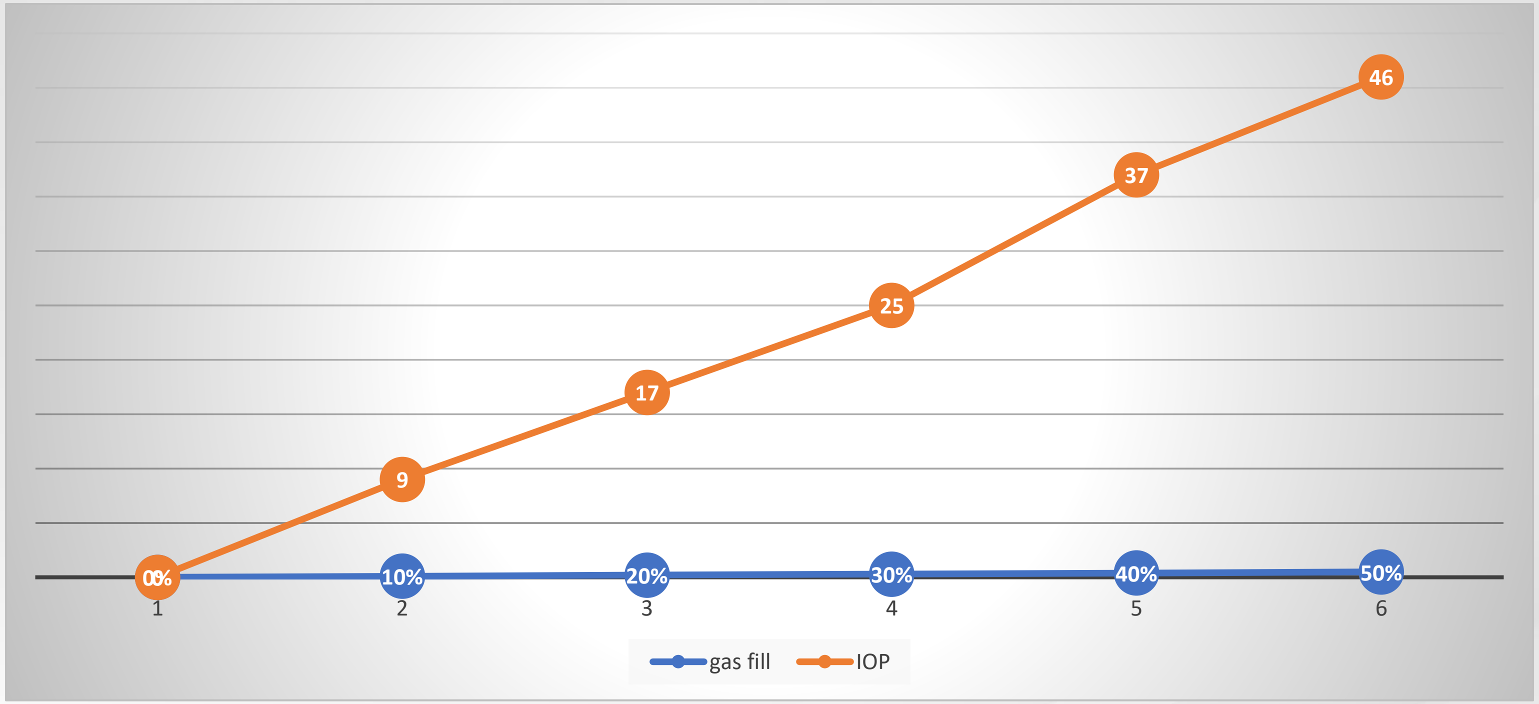


Cabin pressure is maintained at 6000 – 8000 ft altitude

IOP with different SF6 volumes



LHR – AD

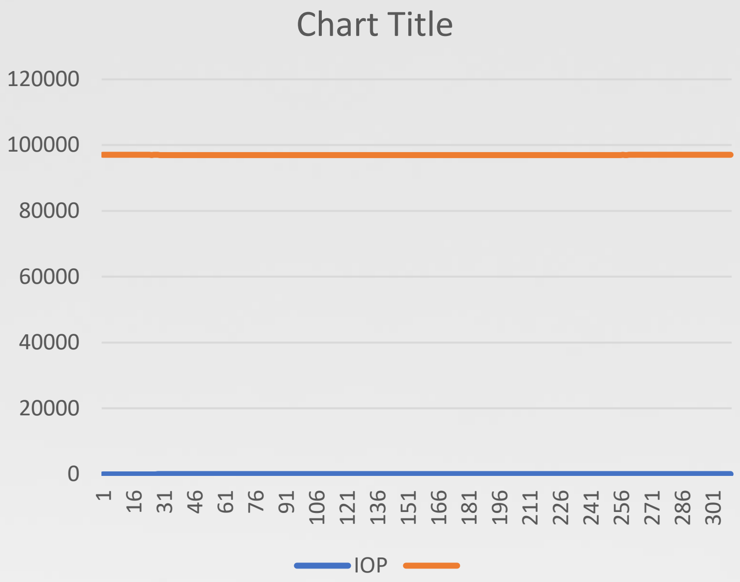


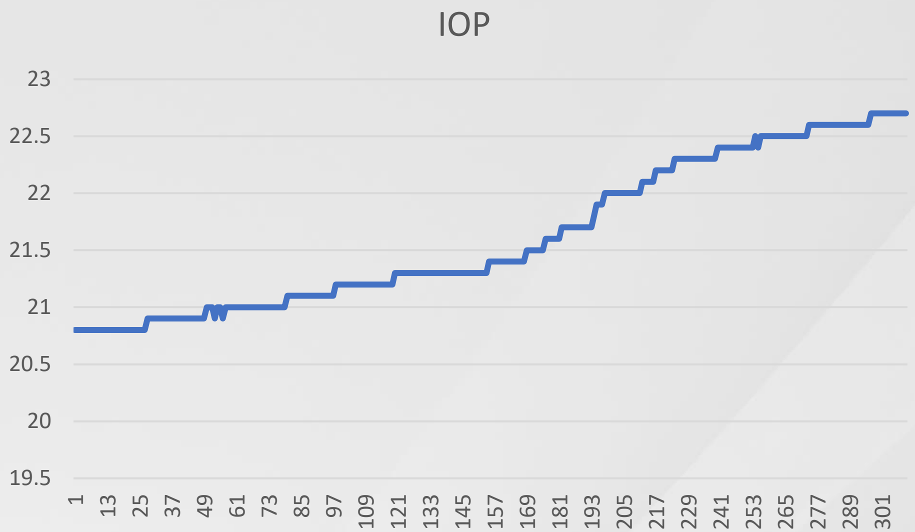
A patient with 50% fill of SF6 20%

will have an IOP rise of + 47 mmHg for 4.5 hours - High Risk

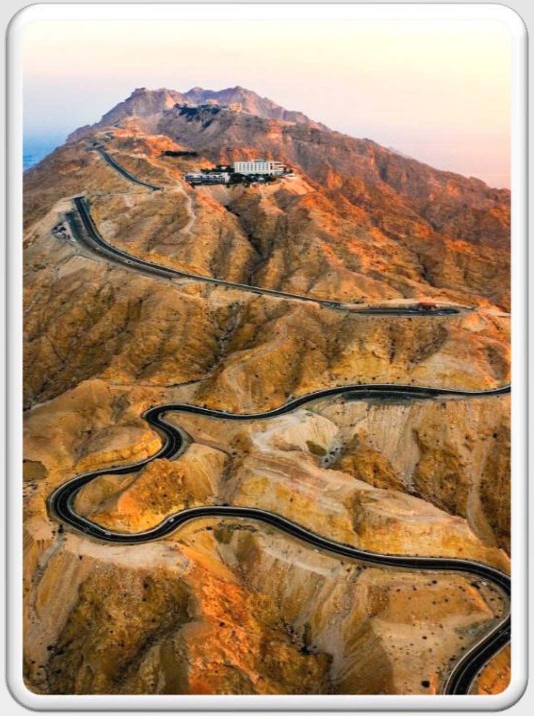
UAE Data

3 Floor Villa – Al Ain



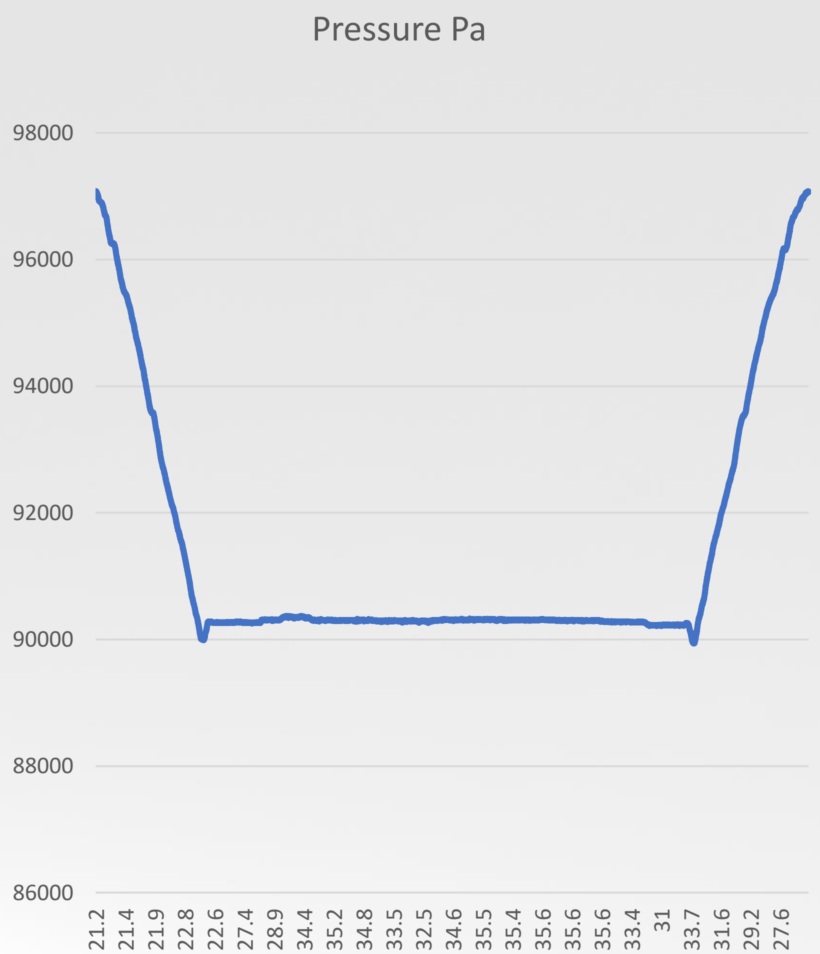


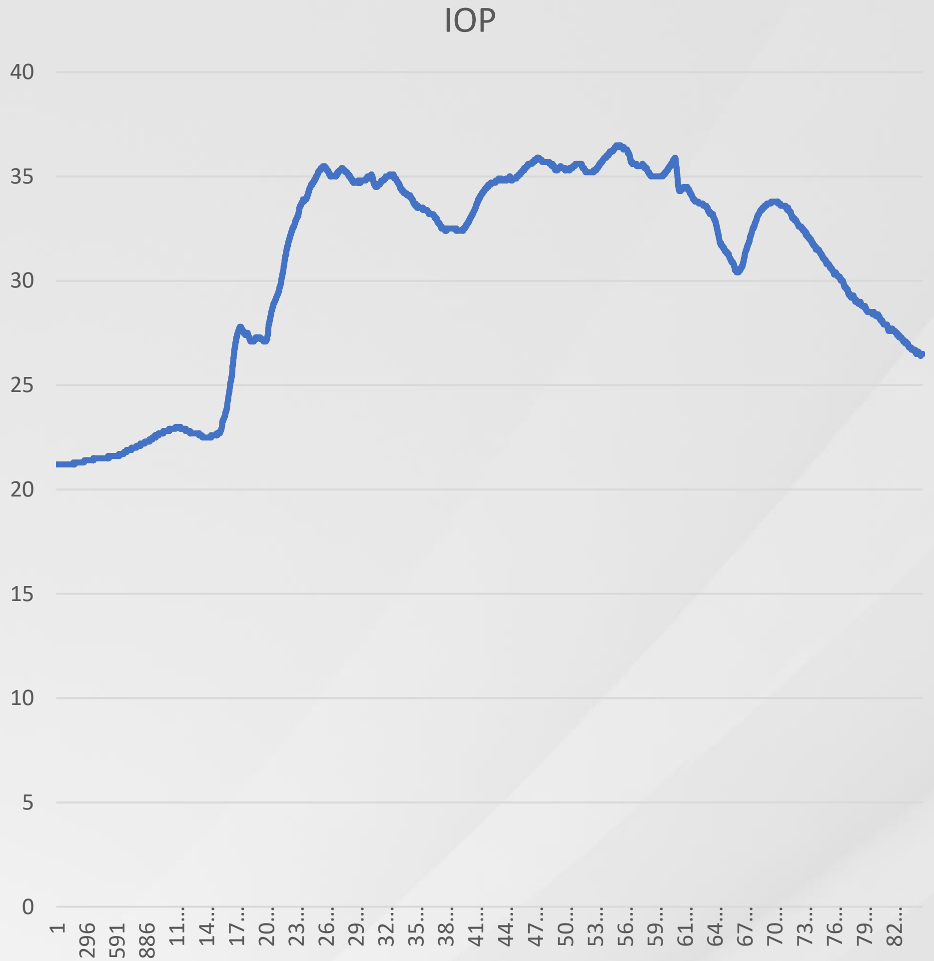
A patient with 50% fill of SF6 20% will have an IOP rise of + 1.8 mmHg – Low Risk



Jebel Hafeet

4000 ft above see level

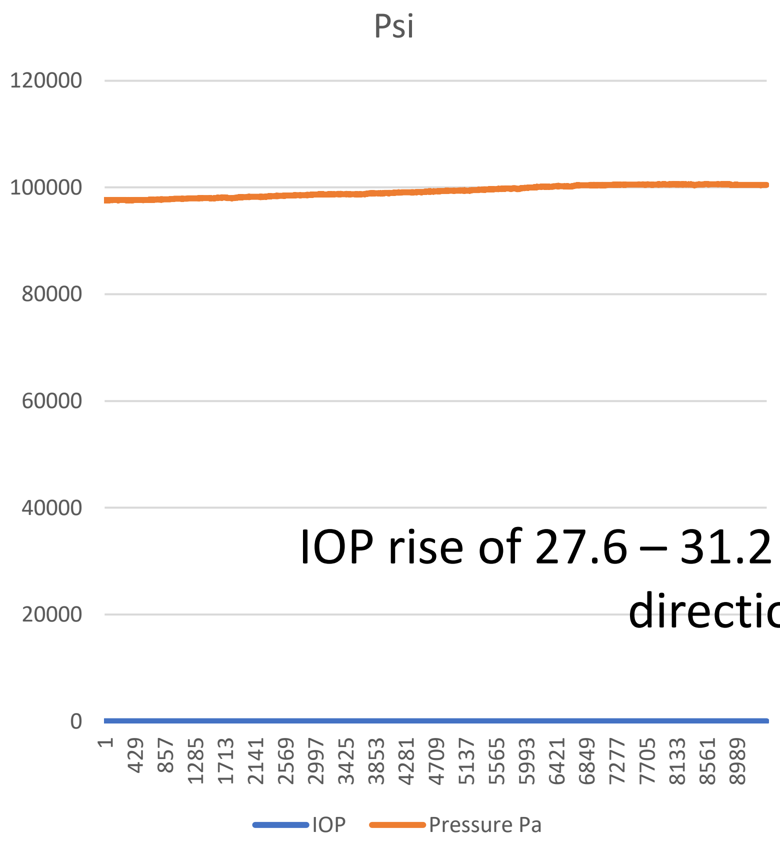


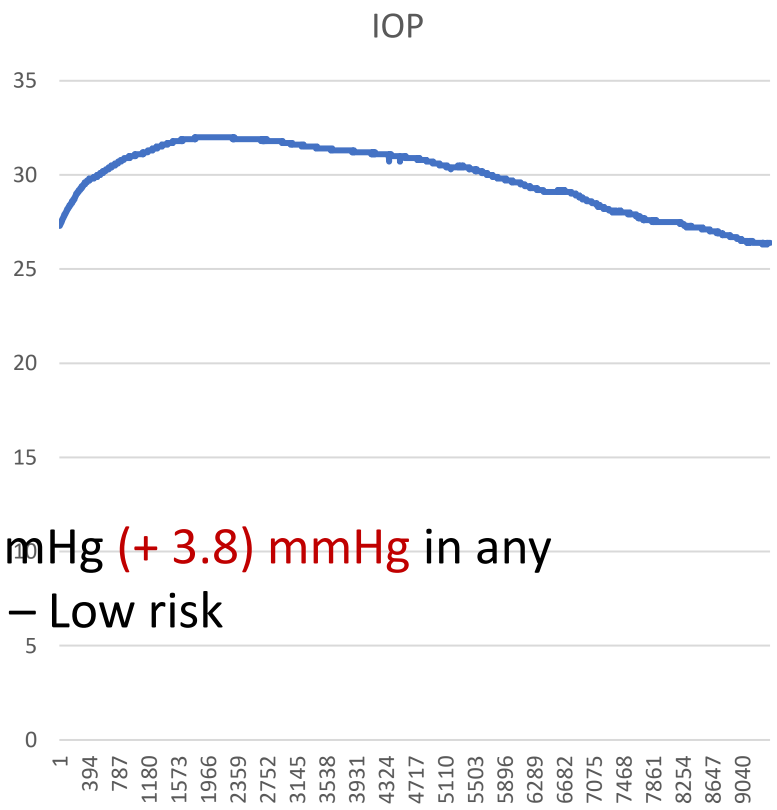


A patient with 50% fill of SF6 20%

will have an IOP rise of + 37 mmHg - High Risk

A.A ⇄ AD A.A ⇄ Dubai





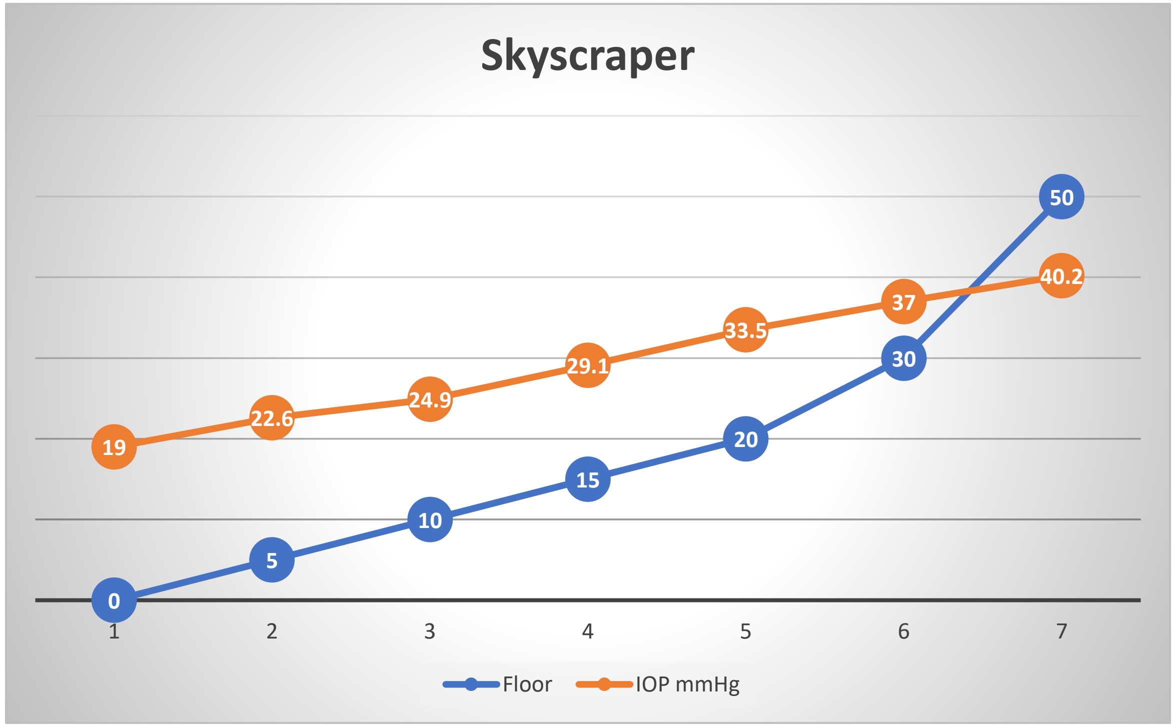
IOP rise of 27.6 – 31.2 mmHg (+ 3.8) mmHg in any direction – Low risk

Skyscraper

- 63 floors / 991 ft
- \- iop:

\- @ Ground floor, 5th , 10th
15th , 20th , 30TH & 50TH..

Floor	IOP mmHg
0	19
5	22.6
10	24.9
15	29.1
20	33.5
30	37
50	40.2



Conclusion

<u>Low risk:</u>

- Train, car on FLAT ground travel
- 2 – 3 Foor villa
- skyscrapers up to 10 floors

<u>Medium and high risk:</u>

- Air travel with gas fill <10% - Medium
- Air travel with gas fill > 10% - High
- High building above 10 floors with 50% gas fill – High

limitations

<u>FACTORS EXCLUDED:</u>

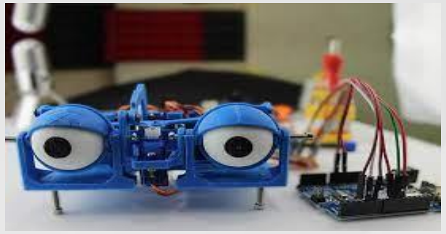
- Base line IOP (we assumed 20 mmHg as base line IOP).

- Atmospheric temperature.

- Patients Bio-physiology(COPD, Asthma). i.e O2 & Nitrogen concentration not counted for.

Theoretical solutions (phase 2)

Mobile eye module with IOP measure



Biophysical analysis of algorithm (formula) to correlate psi with IOP

$$E = \frac{RT}{zF} \ln \frac{C_o}{C_i}$$

Real time IOP measure

Thank you
&
discussion